

# MUSTELICOLA ANTARCTICUS SP. NOV. (CESTODA: TRYPANORHYNCHA) FROM AUSTRALIAN ELASMOBRANCHS, AND A REASSESSMENT OF THE FAMILY MUSTELICOLIDAE DOLLFUS, 1969

by RONALD A. CAMPBELL\* & IAN BEVERIDGE†

## Summary

CAMPBELL, R. A. & BEVERIDGE, I. (1988) *Mustelicola antarcticus* sp. nov. (Cestoda: Trypanorhyncha) from Australian elasmobranchs, and a reassessment of the family Mustelicolidae Dollfus, 1969. *Trans. R. Soc. S. Aust.* 112( ), 153-161, 30 November, 1988.

*Mustelicola antarcticus* sp. nov. is described from adult worms in the spiral valve of *Mustelus antarcticus* (Güenther) collected in coastal waters off Bicheno, Tasmania. Characters differentiating *M. antarcticus* from *M. woodsholei* Dollfus, 1969, the only other known species, are a much smaller ratio of pars bulbosa to pars vaginalis (1: 1.3 versus 1: 2.1), approximately twice as many testes per segment (av. 780 versus 300), and reversed order of hook sizes 2(2') and 3(3') for the two species. The armature of *M. woodsholei* is completely described for the first time. As in *M. antarcticus*, it consists of a unique poecilacanthous type consisting of three double chainettes and is most similar to members of the Lacistorhynchidae Guiart, 1927 and Callitetrarhynchinae Dollfus, 1942. Other new morphological features described are an hermaphroditic sac, pre-formed uterine pore, lack of true prebulbar organs, and origin of the retractor muscle in the anterior 1/3 of the bulb. The family Mustelicolidae is considered justified, based on unique features of the armature, scolex and genitalia, and is redefined accordingly.

KEY WORDS: *Mustelicola*, Cestoda, Trypanorhyncha, new species.

## Introduction

Dollfus (1969) erected the family Mustelicolidae for a single trypanorhynch found in the spiral valve of *Mustelus canis* (Mitchill, 1815) caught in Atlantic coastal waters near Woods Hole, Massachusetts. Dollfus considered the armature of *Mustelicola woodsholei* to be of the atypical heteroacanthous type though a complete description of the tentacular armature and reproductive system was not provided. Schmidt (1986) revised the systematics of the cestodes and considered Mustelicolidae to be a synonym of Eutetrarhynchidae Guiart, 1927, making the genus *Mustelicola* Dollfus, 1969 a synonym of *Parachristianella* Dollfus, 1946. The precise position of the species within *Parachristianella* was not specified. Schmidt's proposed synonymy of an atypical heteroacanth (*Mustelicola*) with a typical heteroacanth (*Parachristianella*) prompted a re-examination of *M. woodsholei* to determine the exact nature of its armature and anatomy. Attempts to find additional specimens of *M. woodsholei* have been fruitless, but a second species, described herein, was recently collected from *Mustelus antarcticus* (Güenther, 1870) off the coast of Tasmania. In this paper the description of the type species is corrected and expanded, a new species is added to the genus, the

taxonomic position of the family re-assessed, and the family Mustelicolidae redefined.

## Materials and Methods

Mustelicolid cestodes were found in the spiral valves of two of 73 sharks (*Mustelus antarcticus*) examined off southern Australian coasts and were fixed in hot 10% buffered formalin. Whole mounted specimens were stained with Celestine blue, dehydrated in ethanol, cleared in clove oil and mounted in balsam. Tentacles were dissected free, examined in glycerol, and mounted in glycerine jelly. Some segments were embedded in paraffin, serially sectioned at 8-10 µm, and stained with Harris' hematoxylin and eosin. Dollfus' holotype was examined from the Museum National d'Histoire Naturelle, Paris. The specimen was remounted and a tentacle removed and examined to provide precise orientation of the armature. Drawings were made with the aid of a drawing tube.

Measurements are given in micrometers, unless otherwise stated, as the range followed by the mean and the number of measurements (n) in parentheses.

Terminology for trypanorhynch morphology follows Dollfus (1942). Specimens have been deposited in the South Australian Museum (SAM), Adelaide.

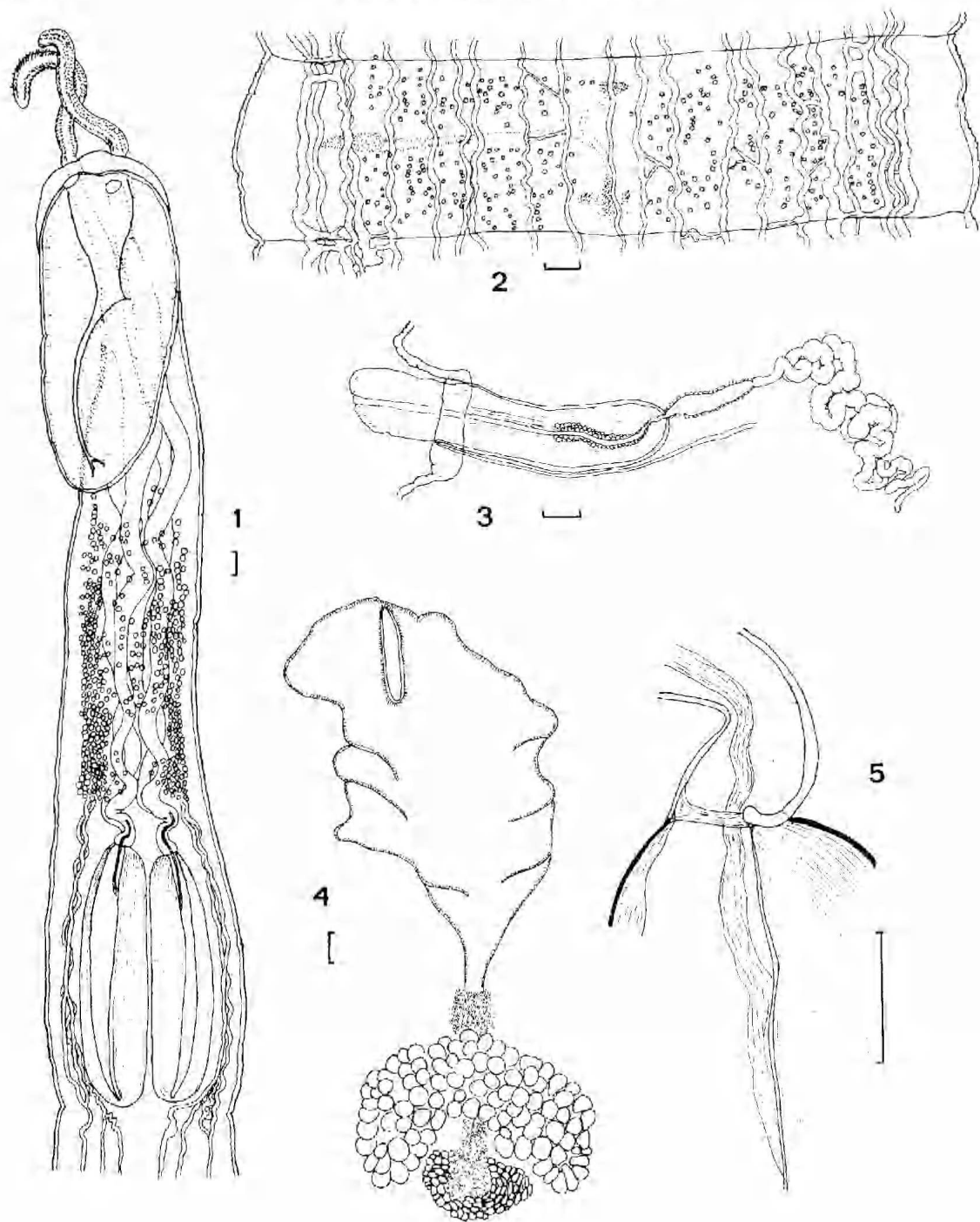
## *Mustelicola woodsholei* Dollfus, 1969

FIGS 1-9

**Description:** Measurements of the holotype specimen. Scolex and strobila acraspedote, total length 6.7 cm, maximum width 1070. Scolex 4160

\* Dept. of Biology, Southeastern Massachusetts University, North Dartmouth, Massachusetts 02747, U.S.A.

† Central Veterinary Laboratories, c/o Institute of Medical and Veterinary Science, Frome Road, Adelaide, S. Aust. 5000



FIGS 1-5. Anatomy of *Mustelicola woodsholei*. 1. Scolex. 2. Immature proglottid showing osmoregulatory ducts. 3. Male genital terminalia. 4. Uterus and preformed uterine pore. 5. Detail of bulb showing origin of tentacle sheath and insertion of retractor muscle. Scale lines: 0.1 mm.

long, subcylindrical, slightly wider in region of bulbs, maximum width in region of bulbs, 860. Two bothridia, oval, elongate, 1520 long, maximum width 640, with broad indistinct rim, not indented posteriorly. Pars vaginalis 2840 long, tentacle sheaths slightly sinuous, not coiled; each sheath originating from bulb in prominent, symmetrical, lateral sinuosity; circular muscle bands similar to those associated with prebulbar organ present at posterior end of sheath, but thickening of lateral wall of sheath and "nucleus" absent; numerous gland cells surround tentacle sheaths in pedunculus scoleci. Bulbs short, 1200 long, 280 in diameter; retractor muscle originates in anterior third of bulbs. Pars post-bulbosa, 200 long; junction of scolex and neck demarcated by a slight constriction. Scolex ratio (pbo: py: pbulb) 1: 2.1: 0.8.

Tentacles not fully extended, longest tentacle 1400; diameter 80 at base, 70 in mid-region; basal swelling and distinct basal armature absent. Armature heteromorphous, poeciloacanthous. Principal rows alternate, beginning on internal face; hooks hollow, arranged in ascending half spiral rows of six hooks each (Fig. 7). Hooks 1(1') to 4(4') rose-thorned shaped, with gently curved blades and long bases of implantation; hooks 1(1') 24-30 (28, n=10) long, bases 18-28 (24, n=10), height 13-18; hooks 2(2') slightly larger, blade 26-38 (33, n=10) long, base 22-28 (24, n=10), height 17-24; hooks 3(3') 30-34 (33, n=10) long, base 20-22 (21, n=10), height 20-24; hooks 4(4') 26-30 (28, n=10) long, base 14-21 (17, n=10), height 17-20; hooks 5(5') spiniform, 14-22 (19, n=10) long, base short, 8-14 (11, n=10), height 10-14; hooks 6(6') in tandem or "satellite" position with respect to 5(5'), spiniform, blade 14-16 (15, n=10) long, base 6-8 (7, n=10), height 10-12. External surface of tentacle with 3 double chainettes, distinctly separated from principal rows, paired elements in each chainette opposite each row of principle hooks; chainette elements subtriangular, 16-22 (19, n=10) long, base 12-16 (14, n=10), height 10-13.

First evidence of segmentation 900 from scolex; segments initially much wider than long, becoming almost as long as wide. Mature segments acraspedote, 1900-2500 (2240, n=5) by 3080-3470 (3260, n=5); genital pores alternate irregularly; genital pore 45-50% of segment length from anterior margin. Cirrus (?) sac elongate, 890-980 (930, n=4) by 200-260 (220, n=4), cirrus unarmed, sinuous when retracted; proximal cirrus surrounded by a few layers of gland cells; internal seminal vesicle absent; external seminal vesicle elongate, diminutive, with single surrounding layer of cells; vas deferens passes medially, coils anteriorly then posteriorly to ovarian isthmus. Testes numerous, approximately 300 in immature segments, scattered through

medulla; testis diameter 40-50 (43, n=5). Vagina a very thin tube, closely paralleling cirrus sac along posterior margin; course of vagina could not be traced to genital pore. Ovary bilobed in dorsoventral view, situated near posterior margin of segment, lobes 350-450 (390, n=5) by 310-380 (350, n=5); Mehlis' gland post-ovarian 280-300 (200, n=5) by 330-400 (360, n=5), U-shaped; uterine duct covered by dense mass of gland cells, passes anteriorly to join uterus about 150 anterior to ovarian isthmus; uterus thin-walled, saccular, extends to anterior margin of segment; preformed uterine pore present near anterior end of uterus. Vitelline glands follicular, circumcortical, follicles c. 50 in diameter.

Osmoregulatory system complex, most clearly visible in immature segments; complex of 4-6 large canals present at lateral margins of segments, canals anastomose frequently; on dorsal and ventral surfaces of segments are 10-12 narrower canals, either straight or regularly sinuous which branch and anastomose infrequently; three pairs of longitudinal canals visible in posterior end of scolex; anterior commissures not visible.

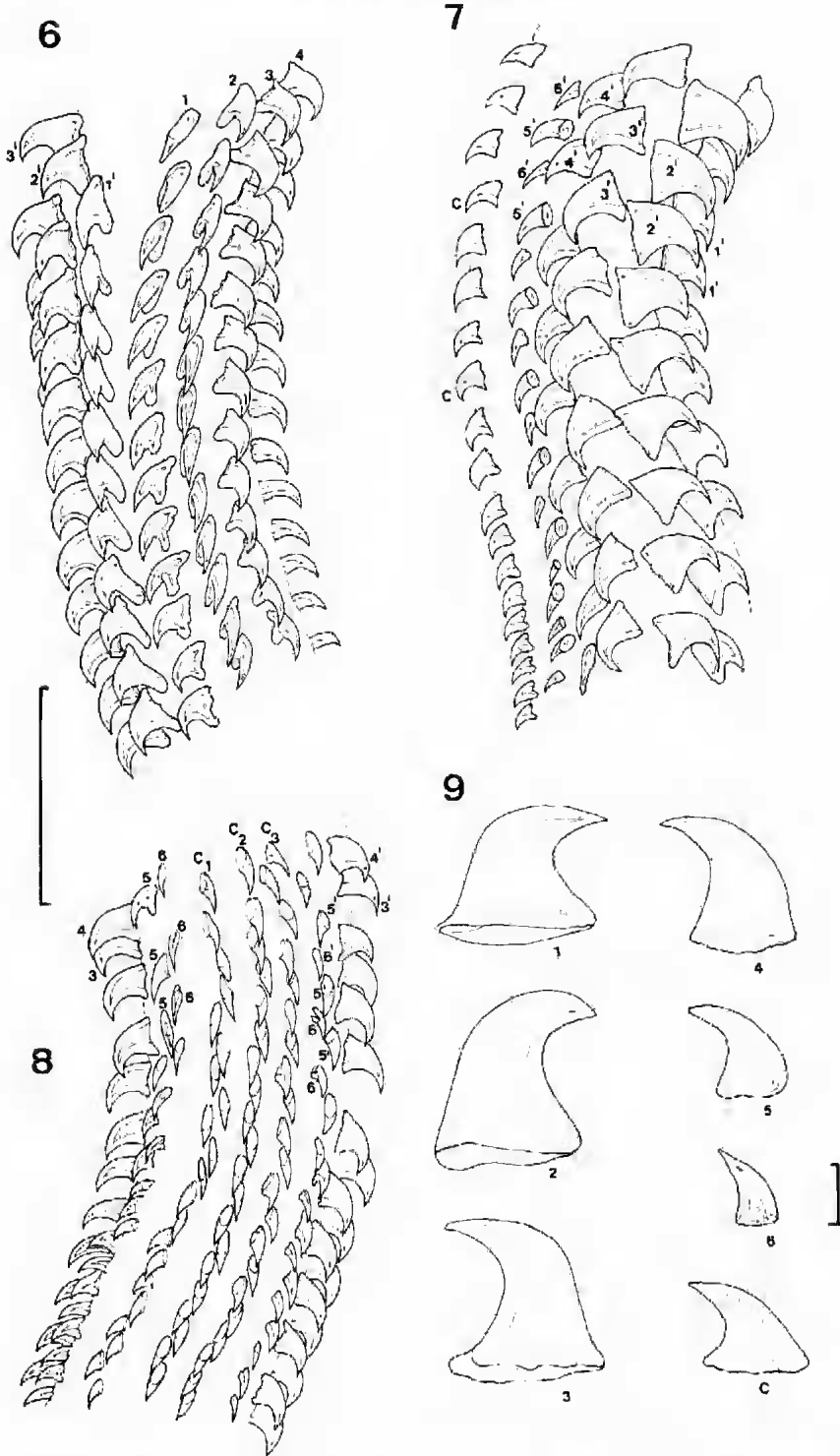
Eggs ovoid, 43-55 (45, n=3) by 25-35 (28, n=3). *Host and Locality*: *Mustelus canis* (Mitchill, 1815), at Woods Hole, Massachusetts, U.S.A.

#### *Mustelicola antarcticus* sp. nov.

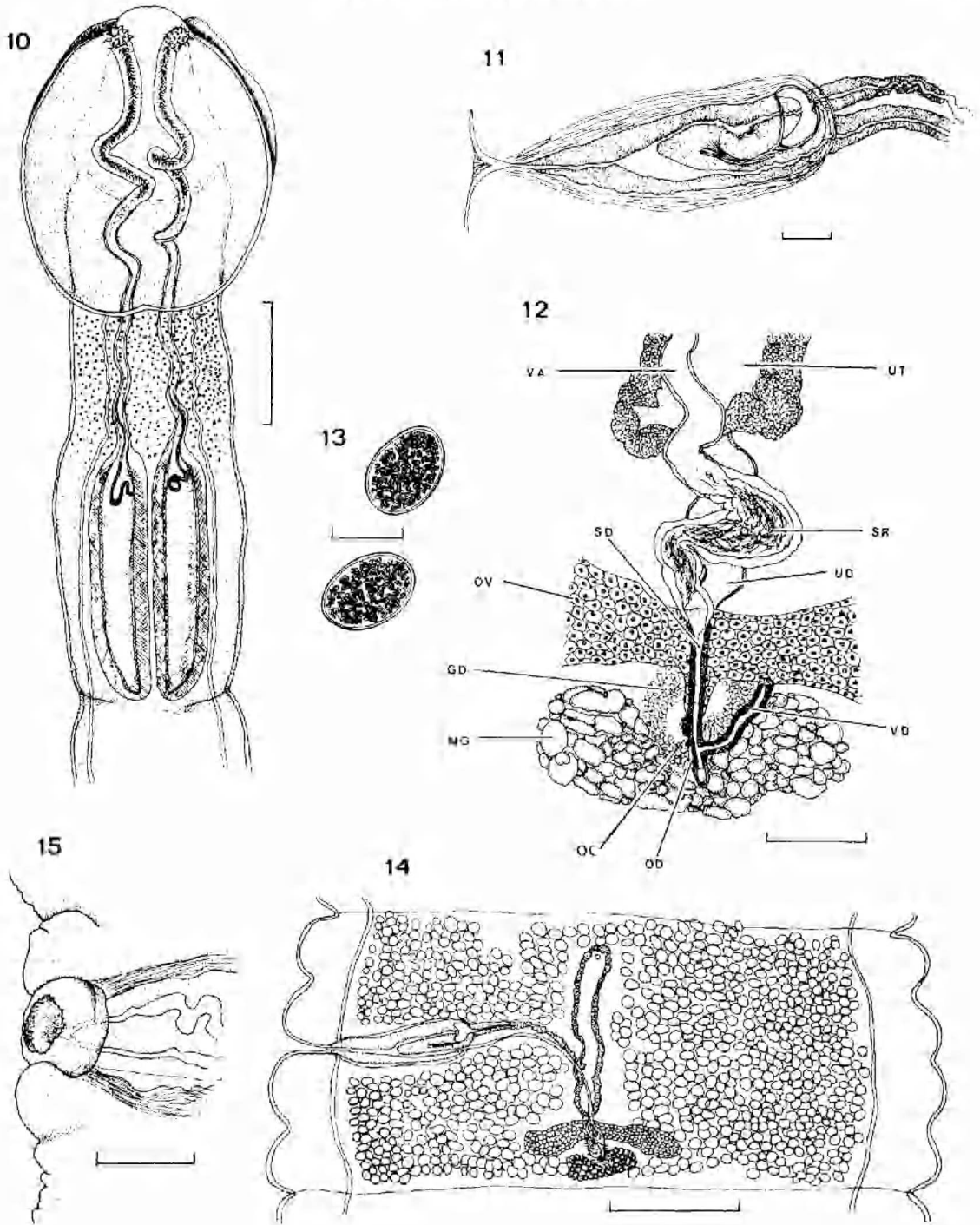
FIGS 10-19

*Description*: Measurements of three fragmented adult specimens. Scolex and strobila acraspedote, strobila up to 6 cm long; maximum width 4.1 mm. Scolex 2720-2832 (n=2) long, subcylindrical, slightly distended in region of bulbs, maximum width at bulbs 792; scolex demarcated from neck by a slight constriction. Two bothridia, broadly oval, rim indistinct, slightly indented posteriorly, length 1000-1140 (n=4) by 980-1020 (n=4). Pars vaginalis 1520-1640 (n=2), tapering into junction with bulbs; tentacle sheaths slightly sinuous; small gland cells scattered in parenchyma of pedunculus scoleci. Bulbs 1080-1240 by 240-320 in diameter; prebulbar organs absent; retractor muscle originates near anterior extremity of bulb; pars postbulbosa extremely short, 80 long. Scolex separated from strobila by slight constriction. Scolex ratio (pbo: py: pbulb) 1:1.3: 0.9.

Armature poeciloacanthous, with three chainettes of paired hooks on internal face. Fully everted tentacles 1.7 mm long; diameter 114 at base, 99 at mid-tentacle, 46 at tip; basal armature and swelling absent. Principal rows alternate, beginning on internal face, forming ascending half spirals of six hooks each. Hooks 1(1') rose-thorn shaped, with sharply angular blades and long bases of



FIGS 6-9. Armature of *Mustelicola woodsholei*. 6. Internal face, metabasal region, turned slightly toward antibothridial face. 7. Antibothridial face, metabasal region, external face on left. 8. External face, metabasal region, showing three double chainettes (C<sub>1</sub>-C<sub>3</sub>). 9. Hooks 1-6 of principal row drawn to scale and chainette hook (c). Scale lines: Figs 6-8, 0.1 mm; Fig 9, 0.01 mm.



FIGS 10-15. Anatomy of *Mustelicola antarcticus* sp. nov. 10, Scolex. 11, Hermaphroditic sac. 12, Female reproductive system. 13, Eggs. 14, Mature proglottid. 15, Bulbous eversion of genital pore. Scale lines: Figs 10, 14, 0.5 mm; Fig 15, 0.3 mm; Figs 11, 12, 0.1 mm; Fig. 13, 0.03 mm. GD, gland cells; MG, Mehlis' glands; OC, oocapt; OD, oviduct; OV, ovary; SD, sperm duct; SR, seminal receptacle; UD, uterine duct; UT, uterus; VA, vagina; VD, vitelline duct.



implantation, blades 33–36 (35,  $n=10$ ) long, height 15–19 ( $n=10$ ); hooks 2(2') larger, blade length 39–42 (40,  $n=10$ ), base 29–31 (30,  $n=10$ ), height 13–21 ( $n=10$ ). Hooks 3(3') similar to 2(2') but smaller; blades 32–36 (34,  $n=10$ ) long, base 23–26 (24,  $n=10$ ), height 15–28 ( $n=10$ ); hooks 4(4') only slightly curved, 27–30 (29,  $n=10$ ) long, base length 17–18 (17,  $n=10$ ), height 15–21 ( $n=10$ ); hooks 5(5') smaller, 21–22 (21,  $n=10$ ) long; bases 14–16 (15,  $n=10$ ), height 13–15 ( $n=10$ ); hooks 6(6') in tandem or "satellite" position anterior to 5(5'), spiniform, 17–18 (17,  $n=10$ ) long, base 6–9 (8,  $n=10$ ), height 10–13 ( $n=10$ ). External surface of tentacle with three double chainettes, distinctly separated from principal rows, chainette elements subtriangular, 22–25 (23,  $n=10$ ) long, base 12–14 (13,  $n=10$ ), height 13–17 ( $n=10$ ).

Number of segments about 200 ( $n=1$ ). First segments appear 1.7–2 mm posterior to scolex. All segments wider than long, acraspedote, enlarging with age. Mature segments always wider than long, 900–3400 by 1560–5600. Gravid segments always longer than wide, 1080–1800 by 3900–4200. Genital pores marginal, irregularly alternating, equatorial, located 50% of segment length from anterior margin. Testes medullary, subspherical, 42–76 by 38–49 ( $n=20$ ), layered, occupying available space between longitudinal osmoregulatory canals and extremities of segment. Testes number about 741–803 (780,  $n=5$ ) per segment. Hermaphroditic sac 544–1160 (696,  $n=10$ ) by 176–352 (248), surrounded by weakly developed layer of muscle fibres. Cirrus unarmed, glandular, immediately distal to ovoid internal seminal vesicle. Vagina median, dilated to form seminal receptacle anterior to ovarian isthmus, turns laterally, lying parallel with posterior margin of hermaphroditic sac and then enters sac; genital sinus opens by a single duct at genital pore. Contraction of walls of hermaphroditic sac forms bulbous, sucker-like protuberance in which cirrus and vagina are brought close to the surface. External seminal vesicle present. Vas deferens coiled, arches toward midline, runs parallel with vagina posteriorly toward ovary. Ovary posteromedial, bilobed in dorsoventral view, crescent-shaped, maximum dimensions 650–980 by 178–520, isthmus up to 80 long. Mehlis' gland postovarian, shallow U-shaped, maximum dimensions 112–120 by 256–288. Vitellaria follicular, irregularly shaped, forming a layer enclosing osmoregulatory canals and reproductive organs, maximum dimensions of follicles 56–64. Uterus median, thick-walled, terminating near anterior margin of segment, voluminous in gravid segments. Uterine pore near distal extremity of uterus. Eggs oval, 38–49.5 (45.6,  $n=10$ ) by 26.6–34.5 (30.4,  $n=10$ ), thick-shelled, non-operculate, unembryonated.

*Host and Locality:* *Mustelus antarcticus* (Guenther, 1870) (type host), off Bicheno, Tasmania, coll. B. G. Robertson.

*Site in host:* Spiral valve.

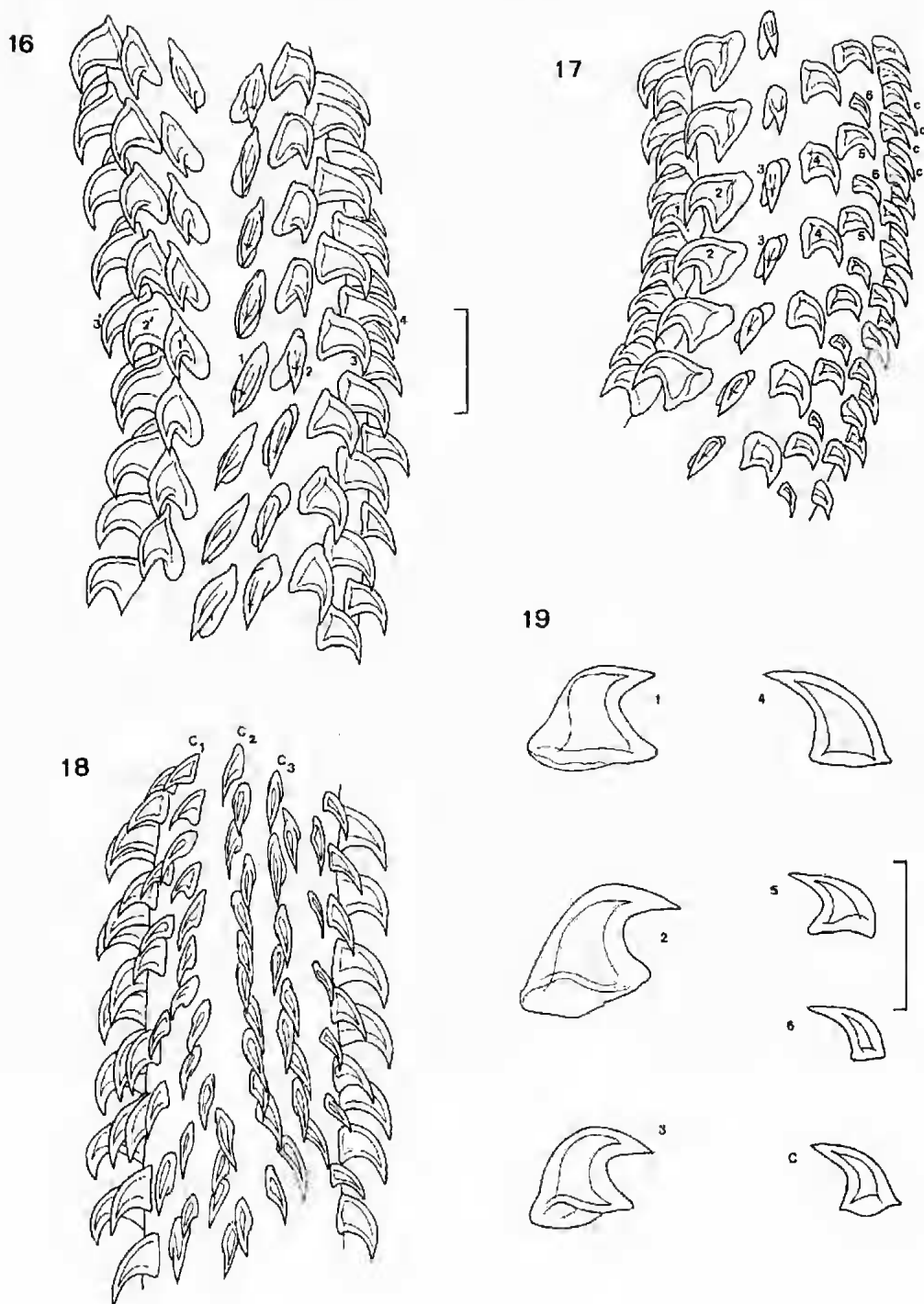
*Types:* Holotype SAM V4104, two paratypes SAM 17875.

*Etymology:* The specific name is after that of its host, *M. antarcticus*. Following Article 30a(i) of the International Code of Zoological Nomenclature, the generic name is masculine in gender.

## Discussion

Dollfus (1969) described *M. woodsholei* and erected the genus *Mustelicola* and family Mustelicolidae for it based on a single specimen. Distinctive characters of the new genus were based upon the armature, viz. *Mustelicola* is an atypical heteroacanth with twice as many hooks in longitudinal files of the external face as occur in longitudinal files of the internal face (Dollfus 1969). This diagnosis was never expanded. Schmidt (1986) subsequently synonymised both the family and genus with the typical heteroacanth *Parachristianella* in the Eutetrarhynchidae.

Unfortunately only a single specimen of *M. woodsholei* exists and it is not satisfactory for the complete description of the reproductive system. However, some specimens of the new species, *M. antarcticus* described above, were gravid and clearly provide these details. A generic definition can therefore be derived from the combined characters of the two species. The two species possess a combination of characters not found together in other trypanorhynch cestodes, foremost of which is the type of armature. Examination of the armature of the type species, *M. woodsholei*, clearly shows major discrepancies with the original description (Dollfus 1969) and these must be addressed because some of them have major consequences for its taxonomic position. In addition, four characters differ substantially from the original description. Firstly, a preformed uterine pore is present and clearly visible as a mass of cells at the anterior end of the uterine anlagen in immature segments. Secondly, an external seminal vesicle is present. Thirdly, the tentacle retractor muscle originates in the anterior third of the bulbous not at the posterior end. Fourthly, a typical prebulbar organ is not present. Muscle elements surrounding the origin of the sheath are present in *Mustelicola* but it is not comparable to the prebulbar organ of eutetrarhynchids. In the latter group, an enlarged projection of the external surface of the tentacle sheath,



FIGS 16-19. Armature of *Mustelicola antarticus* sp. nov. 16. Internal face, metabasal region. 17. Bothridial face, metabasal region, external face is on right. 18. External face, metabasal region, showing 3 double chainettes, C<sub>1</sub>-C<sub>3</sub>. Note slight counterclockwise torsion of tentacle. 19. Hooks 1-6 of principal row drawn to same scale and chainette hook (c). Scale lines: Figs 16-18, 0.05 mm; Fig 19, 0.03 mm.

sometimes described as being nucleated and supported by circular bands of muscle running around the tentacle sheath is clearly visible (Dollfus 1942).

The most important character of the genus, is the armature which is poeciloacanthous in form and not that of an atypical heteroacanth or a typical heteroacanth. Dollfus (1969) did not illustrate the external surface of the tentacle armature fully. By re-orienting the type specimen and examining an isolated tentacle, a unique poeciloacanthous arrangement consisting of three double chainettes was clearly seen (Figs 6-9). This same armature was seen in specimens of the new species, *M. antarcticus*, described above. When compared with the armature of genera such as *Lacistorhynchus* and *Callitetrarhynchus* there is a remarkable constancy of hook number. In both of these genera, each row contains five major hooks. Hook 6, however, is small and is situated slightly out of alignment with the principle row. Hooks 7 and 8, the so-called "satellite hooks", are arranged in tandem, much as the pairs of hooks 9(9') of the chainette. If the armature of *Lacistorhynchus* and *Callitetrarhynchus* were rearranged simply by displacing hook 5 so that it lay in tandem with hook 6, and hooks 7 to 9 were of the same shape, then there would be six hooks per principal row and three chainettes formed, exactly the armature present in *Mustelicola*. Because of the similarities of hook number and disposition we believe that *Mustelicola* has close affinities to *Lacistorhynchus* and *Callitetrarhynchus*; both genera, of course, are poeciloacanthous. A hermaphroditic duct is also present in *Mustelicola*, *Lacistorhynchus* and *Callitetrarhynchus*.

Details of the reproductive system of *Mustelicola woodsholei* could not be obtained because the single specimen lacks fully developed segments. However, the major organs can be seen and the vagina can be traced in close parallel to the "cirrus sac" to a point beyond its midlength where it appears to unite. The sac is surrounded by a coat of muscle fibers and a dilation is apparent in the vas deferens before it enters the sac. In *M. woodsholei* all the mature segments have everted cirri and hence the details of the distal ducts cannot be determined. It probably possesses a hermaphroditic sac. In the new species, *M. antarcticus*, details of the "cirrus sac" can be seen clearly. The vagina enters the sac on its posterior margin, and the unarmed cirrus resides in a sinus cavity distal to an internal seminal vesicle. A common duct leads to the genital pore on the segment margin. This arrangement is, therefore, a hermaphroditic sac not a cirrus sac. Contraction of the muscular coat causes formation of a sucker-like protuberance in which the sinus cavity is brought to the surface.

Both *M. woodsholei* and *M. antarcticus* possess armatures of six hooks per principal row and three chainettes, two bothridia, pars bothridialis longer than pars bulbosa, lack prebulbar organs, possess numerous gland cells in the pedunculus scoleci, acraspedote segments, uterine pores, saecate uteri, crescent-shaped ovaries, and U-shaped shell glands. *M. antarcticus* may be distinguished from *M. woodsholei* by the following characters: scolex proportions of pars bothridialis to pars vaginalis (1: 1.3 versus 1: 2.1); hooks 2(2') and 3(3') differ in form (abruptly curved in *M. antarcticus* versus gently curved in *M. woodsholei*) and size (hook length 2(2') markedly larger than 3(3') in *M. antarcticus* but equal to or slightly smaller in *M. woodsholei*; testis number (about 780 in *M. antarcticus* versus about 300 in *M. woodsholei*); internal seminal vesicle in *M. antarcticus* apparently absent in *M. woodsholei*.

We propose that the diagnoses of the family and genus be emended to include these corrections and distinctive characters that separate them from other trypanorhynchs as follows:

#### *Mustelicolidae* Dollfus, 1969, emended

*Diagnosis:* Order Trypanorhyncha. Poeciloacanthous with multiple chainettes opposite principal rows. Scolex with two, well-separated sessile bothridia with free margins. Rhyncheal apparatus well developed. True prebulbar organs absent. Tentacles and bulbs relatively short. Segments numerous. Genital pores marginal. Testes numerous, intervacular, internal or external seminal vesicles present. Ovary posterior. Uterus saccular with ventral pore. Vitellaria circumcortical. Adults parasitic in spiral valve of elasmobranchs. Type and only genus:

#### *Mustelicola* Dollfus, 1969 emended

*Diagnosis:* Scolex acraspedote. Two bothridia patelliform, rimmed, without posterior notch; not contiguous apically. Pars bothridialis longer than pars bulbosa. Bulbs short. Pars postbulbosa very short. Tentacle sheaths irregularly sinuous. Retractor muscle originates in anterior portion of bulb. Tentacles lack basal swelling. Armature consisting of three double chainettes opposite hooks 1(1') of principal rows. Principal rows alternate. Strobila anapolytic (?), segments acraspedote. Genital pores irregularly alternate. Hermaphroditic sac present, cirrus present, internal seminal vesicle present;



external seminal vesicle present. Testes medullary, surround ovary and available intervascular space. Ovary bilobed in dorsoventral view, shell gland well developed; uterus median, pore preformed. Vitelline follicles form a sleeve enclosing all reproductive organs. Eggs anoperculate. Osmoregulatory system complex, anastomosing frequently.

*Type species: Mustelicola woodsholei* Dollfus, 1969.

*Other species: M. antarcticus* sp. nov.

*Hosts:* Spiral valves of triakid sharks.

#### Acknowledgments

Our thanks to Dr A. Petter, Laboratoire des Vers, Muséum National d'Histoire Naturelle, Paris, for loan of the type specimen.

This project was supported financially by the Australian Biological Resources Study.

#### References

- DOLLFUS, R. Ph. (1942) Études critiques sur les tétrarhynques du Muséum de Paris. *Arch. Mus. Natl. Hist. Nat., Paris* **19**, 1-466.
- (1969) Quelques espèces de cestodes Tétrarhynques de la cote Atlantique des États Unis, dont l'une n'était pas connue a l'état adulte. *J. Fish. Res. Board Can.* **26**, 1037-1061.
- SCHMIDT, G. D. (1986) "Handbook of Tapeworm Identification." (CRC Press, Inc., Boca Raton, Florida).